ACETABULAR CUP ASSEMBLY WITH SELECTED BEARING

This is a continuation-in-part of application serial no. 09/083,406, filed May 22, 1998, for ACETABULAR CUP ASSEMBLY WITH SELECTED BEARING.

The present invention relates generally to prosthetic implants and pertains, more specifically, to the implant of acetabular cup assemblies which secure a prosthetic bearing member in the acetabulum for the reception of a femoral head of a prosthetic hip joint.

The replacement of members of a natural hip joint with prosthetic implants has become widespread and is being accomplished with ever-increasing frequency. The variety of conditions encountered when effecting such implants has led to the use of various bearing materials placed at an optimum position and orientation, as determined by conditions encountered at the site of the implant. The choice of a particular material for the bearing, as well as the size, positioning and orientation of the bearing member, is determined by the surgeon performing the procedure. Usually such choices are made on the basis of a pre-operative assessment of the needs of a particular patient; however, at times the choices are not completed until the implant site actually is being prepared and conditions encountered at the site can be evaluated during the implant procedure itself. Accordingly, it would be advantageous to have available a greater range of interoperative choice, as well as pre-operative choice, so as to enable a surgeon to accommodate the needs of a particular patient as determined by either or both a pre-operative assessment and an

evaluation of conditions encountered at a particular implant site, and to do so in a practical manner.

The present invention provides the surgeon with the ability to choose, either pre-operatively or interoperatively, an optimum material, position and orientation for a bearing member of an acetabular cup assembly to be implanted at a particular implant site, with increased ease and at lowered expense. As such, the present invention attains several objects and advantages, some of which are summarized as follows: Accommodates a wider choice of bearing materials in the bearing member of an acetabular cup assembly, while utilizing a common acetabular shell; enables the choice of size, position and orientation of the bearing surface of a bearing member selected for assembly with a particular acetabular shell; increases the range of bearing materials, as well as bearing size, positioning and orientation, and renders the choices available in a practical manner for either pre-operative or interoperative selection; allows a surgeon greater latitude in accommodating the needs of different patients while meeting the requirements imposed by various conditions encountered at a particular implant site, and enables appropriate choices to be made interoperatively, as well as pre-operatively; promotes greater accuracy in the replacement of a natural hip joint, with increased economy; provides a surgeon with the ability to make both pre-operative choices and interoperative choices from a wider range of options; enables the securement of a bearing member of selected material within a common acetabular shell, with increased ease and economy, and without complex, specialized instruments; facilitates

the insertion and securement of a selected bearing member within an acetabular shell in appropriate alignment and orientation of the bearing member within the acetabular shell; provides an acetabular cup assembly having a bearing member of appropriate bearing material and accurate sizing, positioning and orientation, with economy of manufacture and use, and long-term reliability.

The above objects and advantages, as well as further objects and advantages, are attained by the present invention which may be described briefly as an acetabular cup assembly for receiving a proximal end of a femoral component of a prosthetic hip implant, the femoral component including a head member and a neck member depending from the head member, the acetabular cup assembly having an external shell member with an internal cavity, and an internal bearing member for securement within the cavity to receive the head member of the femoral component for rotational movement within the bearing member, the internal bearing member being selected from a plurality of bearing members having different characteristics such that the acetabular cup assembly selectively is provided with characteristics corresponding to the characteristics of the selected internal bearing member, the acetabular cup assembly comprising: a metallic securing member for reception within the cavity of the acetabular shell, the securing member extending between and upper end and a lower end and including an external securing element and an internal receptor element; an external receptor element on the bearing member, the external receptor element and the internal receptor element being compatible with

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particular characteristics of the bearing member such that upon engagement of the external receptor element with the internal receptor element the internal bearing member is secured to the securing member with the lower end of the bearing member spaced upwardly a prescribed distance from the lower end of the securing member; and an internal securing element within the cavity of the shell member, the internal securing element being essentially complementary to the external securing element of the securing member such that upon selective engagement of the external securing element with the internal securing element the securing member is secured selectively within the shell member; the prescribed distance between the lower end of the bearing member and the lower end of the securing member being such that contact between the neck member of the femoral component and the lower end of the securing member precludes deleterious impingement of the femoral component upon the bearing member.

Further, the present invention provides a shell member for use in an acetabular cup assembly having an internal bearing member for securement within the shell member, the internal bearing member being selected from a plurality of bearing members having different characteristics such that the acetabular cup assembly selectively is provided with characteristics corresponding to the characteristics of the selected internal bearing member, the shell member comprising: an internal cavity; a first securing element within the cavity of the shell member, the first securing element being compatible with the securing characteristics of at least one

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of the plurality of internal bearing members; and a second securing element within the cavity of the shell member, the second securing element being compatible with the securing characteristics of at least another of the plurality of internal bearing members; the first and second securing elements being juxtaposed with one another and placed at relative locations such that the effectiveness of each of the first and second securing elements is maintained in the presence of the other of the first and second securing elements, whereby the one and the another of the internal bearing members each is selectable for effective securement within the shell member to complete the acetabular cup assembly.

In addition, the present invention includes a kit of component parts for assembling an acetabular cup assembly having an internal bearing member secured within a shell member, the kit comprising: a plurality of bearing members having different characteristics such that the acetabular cup assembly selectively is provided with characteristics corresponding to the characteristics of a selected one of the internal bearing members; the shell member comprising: an internal cavity; a first securing element within the cavity of the shell member, the first securing element being compatible with the securing characteristics of at least one of the plurality of internal bearing members; and a second securing element within the cavity of the shell member, the second securing element being compatible with the securing characteristics of at least another of the plurality of internal bearing members; the first and second securing elements being juxtaposed with one another and placed at

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relative locations such that the effectiveness of each of the first and second securing elements is maintained in the presence of the other of the first and second securing elements, whereby the one and the another of the internal bearing members each is selectable for effective securement within the shell member as the selected one bearing member to complete the acetabular cup assembly.

Still further, the present invention provides an improvement in a method for implanting an acetabular cup assembly having an external shell member with an internal cavity, and an internal bearing member for securement within the cavity, the internal bearing member being selected from a plurality of bearing members having different characteristics such that the acetabular cup assembly selectively is provided with characteristics corresponding to the characteristics of the selected internal bearing member, the improvement comprising the steps of: providing a first securing element within the cavity of the shell member, the first securing element being compatible with the securing characteristics of at least one of the plurality of internal bearing members; providing a second securing element within the cavity of the shell member, the second securing element being compatible with the securing characteristics of at least another of the plurality of internal bearing members; and selecting the one or the another of the internal bearing members and securing the selected internal bearing member within the shell member by engaging the selected internal bearing member with the corresponding first securing element or

second securing element for completion of the acetabular cup assembly.

The invention will be understood more fully, while still further objects and advantages will become apparent, in the following detailed description of preferred embodiments of the invention illustrated in the accompanying drawing, in which:

FIG. 1 is an exploded elevational view, partially sectioned, of an acetabular cup assembly constructed in accordance with the present invention;

FIG. 2 is a top plan view of the shell component of the acetabular cup assembly;

FIG. 3 is a top plan view of the bearing insert component of the acetabular cup assembly;

FIG. 4 is an enlarged fragmentary view of a portion of the shell component as illustrated in FIG. 1;

FIG. 5 is an enlarged fragmentary view of a portion of the bearing insert component as illustrated in FIG. 1;

FIG. 6 is an enlarged fragmentary view of the portions shown in FIGS. 4 and 5, with the acetabular cup assembly assembled;

FIG. 7 is an exploded elevational view, partially sectioned, of the acetabular cup assembly shown utilizing alternate component parts;

FIG. 8 is a top plan view of a securing component of the acetabular cup assembly;

FIG. 9 is an enlarged fragmentary view of a portion of the securing component as illustrated in FIG. 7;

FIG. 10 is an enlarged fragmentary cross-sectional view of a portion of the acetabular cup assembly illustrated in FIG. 7, with the component parts assembled;

FIG. 11 is an exploded elevational view, partially sectioned, of an alternate securing component and bearing insert component for the acetabular cup assembly;

FIG. 12 is an enlarged fragmentary view of a portion of the securing component of FIG. 11;

FIG. 13 is an enlarged fragmentary view of portions of the acetabular cup assembly utilizing the alternate component parts illustrated in FIG. 11, with the component parts assembled;

FIG. 14 is an elevational cross-sectional view of an alternate securing component;

FIG. 15 is an elevational cross-sectional view of another alternate securing component;

FIG. 16 is an exploded elevational view, partially sectioned, of another acetabular cup assembly constructed in accordance with the present invention;

FIG. 17 is an enlarged fragmentary view of a portion of the shell component illustrated in FIG. 16;

FIG. 18 is an enlarged fragmentary view of a portion of the bearing insert component illustrated in FIG. 16;

FIG. 19 is an enlarged fragmentary view of the portions shown in FIGS. 17 and 18, as the bearing insert component is being inserted into the shell component;

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FIG. 20 is an enlarged fragmentary view of the portions shown in FIGS. 17 and 18, with the acetabular cup assembly assembled;

FIG. 21 is an enlarged fragmentary view of a portion of FIG. 18;

FIG. 22 is an exploded elevational view, partially sectioned, showing another embodiment including an assembly in which a bearing component is to be assembled with a securing component;

FIG. 23 is an enlarged fragmentary view of the portion of the securing component and bearing component assembly as the assembly is being inserted into the acetabular shell;

FIG. 24 is an enlarged fragmentary view similar to FIG. 23, and showing the securing component and bearing component assembly assembled within the acetabular shell;

FIG. 25 is a longitudinal cross-sectional view of the assembled securing component, bearing component and acetabular shell, with a femoral head of a femoral component engaged with the securing component; and

FIG. 26 is an enlarged fragmentary longitudinal cross-sectional view of a modified construction.

Referring now to the drawing, and especially to FIGS. 1 through 3 thereof, an acetabular cup assembly constructed in accordance with the present invention is illustrated generally at 20. Acetabular cup assembly 20 includes a shell component in the form of metallic shell member 22 and a bearing insert which, in this instance, is in the form of a plastic bearing member 24. Shell member 22 includes an outer surface 26 having a profile

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configuration which enables the shell member 22 to be seated and fixed in place within an appropriately prepared acetabulum in a now well-known manner. A plurality of screw holes 28 are provided in the shell member 22 for receiving anchoring screws (not shown) when such supplemental securing means are desired. An inner cavity 30 extends upwardly into shell member 22, from a lower opening 32 at a lower end 34 toward an upper end 36. A rim 38 is located at the lower end 34.

Bearing member 24 has a generally domed exterior 40 which is essentially complementary to the cavity 30 of the shell member 22 and extends longitudinally from a base 42 to a top 44. A basal flange 46 extends circumferentially around the base 42 of the bearing member 24 and projects laterally outwardly to provide a transverse bearing face 48 at the base 42 of the bearing member 24. A bearing socket 50 extends upwardly into the bearing member 24 and provides a spherical bearing surface 52 for a complementary femoral head (not shown).

Acetabular cup assembly 20 is to be implanted in stages; that is, the shell member 22 and the bearing member 24 are to be assembled interoperatively, so as to enable appropriate sizing, placement and orientation of the bearing socket 50, based upon a pre-operative assessment or upon an evaluation of conditions encountered at the site of the implant. To that end, alternate bearing members 24 are made available, in a kit of component parts, which kit provides a plurality of bearing members, the alternate bearing members 24 providing corresponding bearing sockets 50

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placed at different locations and orientations, relative to the seated and secured shell member 22, any one of which bearing sockets 50 then being capable of securement in place in the shell member 22, interoperatively, with the bearing surface 52 appropriately located and oriented for accommodating the needs of the patient.

A selected bearing member 24 is secured in place appropriately within the shell member 22 by means of a securing mechanism 60 provided adjacent the lower end 34 of the shell member 22 and adjacent the base 42 of the bearing member 24. Turning now to FIGS. 4 through 6, as well as to FIGS. 1 through 3, securing mechanism 60 is seen to include a securing element in the form of an annular recess 62 extending laterally outwardly into the shell member 22 adjacent the lower end 34. a complementary securing element in the form of an annular rib 64 extends laterally outwardly from the bearing member 24, adjacent the base 42 of the bearing member 24. A preferred material for the plastic bearing member 24 is an ultra-high molecular weight polyethylene commonly used in connection with such bearing members, the securing characteristics of which material include a resiliency sufficient to assure that upon inserting the bearing member 24 into the shell member 22, and seating the bearing member 24 in the shell member 22, as seen in FIG. 6, the annular rib 64 is seated within the annular recess 62 to secure the bearing member 24 within the shell member 22.

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The position and orientation of the bearing socket 50 relative to the fixed shell member 22 are selected by providing the different locations and orientations of the bearing socket 50 within the bearing member 24, as set forth above. Thus, as seen in FIG. 1, the bearing socket 50 may be offset from the central axis C of the bearing member 24, as illustrated in phantom by an alternate offset bearing socket 50A, by varied amounts in different selectable bearing members 24, for the selection of an appropriate position for the bearing socket 50 at the implant site. Likewise, an appropriate orientation of bearing socket 50 is made available through the provision of alternate angled orientations, as illustrated in phantom by an alternately oriented bearing socket 50B in FIG. 1. Once seated in place, the selected bearing member 24 is secured within the shell member 22 by engagement of the complementary securing elements in the form of recess 62 and rib 64, common to the securing mechanism 60 provided for all of the alternate bearing members 24. In addition, once the selected bearing member 24 is seated appropriately within the shell member 22, rotation of the bearing member 24 about the axis C relative to the shell member 22 is precluded by engagement of protrusions 70 extending radially inwardly from the rim 38 of the shell member 22 with counterpart portions 72 of the bearing member 24, adjacent the flange 46 of the bearing member 24.

Should the surgeon determine, either on the basis of a pre-operative assessment of a patient or during the course of the implant procedure, that based upon the needs of a particular

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patient, as determined by the pre-operative assessment or by an evaluation of conditions encountered at the particular implant site, a bearing material having characteristics other than those of the material of bearing member 24 would be more appropriate, acetabular cup assembly 20 provides the surgeon with the ability to choose a bearing member having a bearing material which exhibits characteristics more appropriate to the needs of that particular patient. Thus, as seen in FIGS. 7 through 10, an alternate bearing member 80, provided as another of the plurality of bearing members made available in the aforesaid kit, is constructed of a ceramic material and includes a generally domed exterior portion 82 which extends to a top 84. A bearing socket 86 extends upwardly into the bearing member 80 and provides a spherical bearing surface 88 for a complementary femoral head (not shown).

One of the most effective, convenient, mechanically simple and easily used securement mechanisms available for securing together mechanical components, where neither component is constructed of a resilient material such as the material of plastic bearing member 24, is mating tapered surfaces. The degree to which the tapered surfaces are tapered depends upon securing characteristics of the particular materials being secured together. However, the securing characteristics of ceramic bearing member 80 are such that securement of the bearing member 80 is best accomplished with a securement surface which is essentially cylindrical. Accordingly, bearing member 80 is provided with an external receptor element in the form of a generally cylindrical securement surface 90 which

extends essentially parallel to the central axis C of the bearing member 80, between lower end 92 of the bearing member 80 and the domed exterior portion 82. In order to enable simplified interoperative securement of the bearing member 80 within shell member 22, subsequent to locating and seating shell member 22 within the acetabulum, securing mechanism 60 provides appropriate mating tapered surfaces. Thus, securing mechanism 60 includes a metallic securing member shown in the form of a sleeve 100 having an annular ring portion 102 adjacent a lower end 103 and a domed portion 104 extending between the ring portion 102 and an upper end 105. The domed portion 104 is essentially complementary to the counterpart portion of the inner cavity 30 of the shell member 22, and the ring portion 102 is provided with an external securing element in the form of an external seating surface 106 and an internal receptor element in the form of a generally cylindrical internal securement surface 108. The configuration of the internal securement surface 108 and the configuration of the external securement surface 90 are compatible with the particular characteristics of the material of the bearing member 80 so that upon engagement of the external securement surface 90 with the internal securement surface 108, as by an interference fit, the bearing member 80 is secured to the sleeve 100.

Securing mechanism 60 further includes an internal securing element in the form of internal seating surface 110 located on the shell member 22, within the cavity 30 adjacent the lower end 34 of the shell member 22. Internal seating surface 110 is generally

complementary to external seating surface 106 for mating engagement of the seating surfaces 106 and 110, as seen in FIG. 10. The seating surfaces 106 and 110 are provided with a tapered configuration, as illustrated by angle A, the taper of the configuration being compatible with the securing characteristics of the material of the sleeve 100 and the shell member 22 such that the sleeve 100 is secured within the shell member 22 by virtue of the locking of the tapered seating surfaces 106 and 110 in response to engagement of the seating surfaces 106 and 110. In the preferred embodiment, the shell member 22 and the sleeve 100 are constructed of commercially pure titanium and the angle A is about 6°. Seating surface 110 includes an upper end 112 and a lower end 114 and is divided by the recess 62 into an upper segment 116 and a lower segment 118 (see FIG. 4). By placing the recess 62 essentially midway between the upper end 112 and the lower end 114, engagement of the seating surfaces 106 and 110, and the locking of the seating surfaces 106 and 110 in response to such engagement, is facilitated by virtue of the locking being accomplished along segments 116 and 118 having generally the same, and therefore maximized, axial length. In this manner, the effectiveness of the seating surface 110 in assuring appropriate alignment between the sleeve 100 and the shell member 22 as the sleeve 100 is inserted into the shell member 22 and in subsequently attaining the desired locking engagement with seating surface 106 is not compromised by the presence of the recess 62.

Referring now to FIGS. 11 through 13, should the surgeon desire to employ another material as a bearing material in the acetabular cup assembly 20, another alternative bearing member constructed of that material is available in the aforesaid kit of component parts for securement within the shell member 22. Thus, alternate bearing member 120 is constructed of another metal, such as, for example, a cobalt-chrome alloy. Bearing member 120 includes a generally domed exterior portion 122 which extends to a top 124. A bearing socket 126 extends upwardly into the bearing member 120 and provides a spherical bearing surface 128 for a complementary femoral head (not shown). Bearing member 120 is provided with an external receptor element in the form of an external securing surface 130. Here again, securing mechanism 60 includes a metallic securing member shown in the form of a sleeve 140 having an annular ring portion 142 and a domed portion 144. The domed portion 144 is essentially complementary to the counterpart portion of the inner cavity 30 of the shell member 22, and the ring portion 142 is provided with an external securing element in the form of an external seating surface 146 and an internal receptor element in the form of an internal securement surface 148.

The configuration of the internal securement surface 148 and the configuration of the external securement surface 130 are compatible with the particular securing characteristics of the material of the bearing member 120 so that upon engagement of the external securement surface 130 with the internal securement

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surface 148, the bearing member 120 is secured to the sleeve 140 in response to such engagement and seating of the sleeve 140 on the bearing member 120. To that end, the securement surfaces 130 and 148 are tapered at an angle B which effects a secure lock between the bearing member 120 and the sleeve 140. The sleeve 140, in turn, is secured within the shell member 22 by the lock effected between the seating surfaces 146 and 110. In the preferred embodiment, sleeve 140 and shell member 22 both are constructed of commercially pure titanium and the seating surfaces 146 and 110 are tapered at angle A, compatible with the securing characteristics of the material of sleeve 140 and shell member 22, as described above in connection with sleeve 100. In this manner, the shell member 22 is able to receive any selected one of a plurality of bearing members constructed of different materials, such as bearing members 24, 80 and 120, furnished in the aforesaid kit, with securement of the selected bearing member being effected either pre-operatively or interoperatively with ease, accuracy and minimal effort on the part of the surgeon, and without the necessity for complex special instruments.

Turning now to FIG. 14, where it is desired to select a particular position of the bearing surface of a bearing member relative to a shell member within which the bearing member is to be secured, utilizing a metallic securing member in the form of a sleeve constructed in accordance with the present invention, alternate sleeves are provided in which the relative location of the internal receptor element and the external securing element of

the sleeve differ from sleeve to sleeve. Thus, in an alternate sleeve 150, the internal receptor element includes an internal securement surface 152 having a central axis 154 which extends in a longitudinal direction, the external securing element includes an external seating surface 156 having a central axis 158 which extends in a longitudinal direction, and the central axis 154 is offset laterally from the central axis 158, as seen at 159. A desired position of the bearing surface of a bearing member is attained by selecting a sleeve 150 having a particular offset 159.

A desired orientation of the bearing surface of a bearing member is attained by selecting a sleeve which provides that orientation. As seen in FIG. 15, an alternate sleeve 160 includes an internal securement surface 162 having a central axis 164 which extends in a longitudinal direction, the external securing element includes an external seating surface 166 having a central axis 168 which extends in a longitudinal direction, and the central axis 164 makes an acute angle 169 with the central axis 168 such that the selection of the magnitude of angle 169 results in a concomitant selection of the relative orientation of the surfaces 162 and 166. A desired orientation of the bearing surface of a bearing member is attained by selecting a sleeve 160 having a particular angle 169.

It will be understood that the selected positioning and the selected orientation described in connection with sleeves 150 and 160 are illustrative examples only. Various combinations of positioning and orientation, as well as other positions and orientations, are available by modifying the configuration of the

metallic securing member to accommodate the desired positioning and orientation of the bearing surface of a particular bearing member.

Referring now to FIGS. 16 through 18, another embodiment of the invention is illustrated in the form of acetabular cup assembly 200. Acetabular cup assembly 200 includes a shell component in the form of metallic shell member 212 and a bearing insert which, in this instance, is in the form of a plastic bearing member 214. Shell member 212 has an outer surface 216 having a profile configuration which enables the shell member 212 to be seated and fixed in place within an appropriately prepared acetabulum in a now well-known manner. An inner cavity 220 extends upwardly into shell member 212, from a lower opening 222 at a lower end 224 toward an upper end 226. Rim segments 228 are located at the lower end 224, and fingers 230 depend from the rim segments 228, the preferred number of fingers 230 being four, spaced apart at ninety degrees from one another, for purposes to be set forth in detail below.

Bearing member 214 has a generally domed exterior 240 which is essentially complementary to the cavity 220 of the shell member 212 and extends longitudinally from a base 242 to a top 244. A basal flange 246 extends circumferentially around the base 242 of the bearing member 214 and projects laterally outwardly to provide a transverse bearing face 248 at the base 242 of the bearing member 214. A bearing socket 250 extends upwardly into the bearing member 214 and provides a spherical bearing surface 252 for a complementary femoral head (not shown). Basal flange 246 includes an upper lateral surface 254.

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Acetabular cup assembly 200 is to be implanted in stages; that is, the shell member 212 and the bearing member 214 are to be assembled interoperatively, so as to enable appropriate sizing, placement and orientation of the bearing socket 250, based upon a pre-operative assessment or upon an evaluation of conditions encountered at the site of the implant. To that end, alternate bearing members 214 are made available, the alternate bearing members 214 providing corresponding bearing sockets 250 placed at different locations and orientations, relative to the seated and secured shell member 212, any one of which bearing sockets 250 then being capable of securement in place in the shell member 212, interoperatively, with the bearing surface 252 appropriately located and oriented for accommodating the needs of the patient. Thus, a kit of component parts which include a plurality of bearing members is made available for the selection of an appropriate bearing member 214.

A selected bearing member 214 is secured in place appropriately within the shell member 212 by means of a securing mechanism 260 provided adjacent the lower end 224 of the shell member 212 and adjacent the base 242 of the bearing member 214. Turning now to FIGS. 19 and 20, as well as to FIGS. 16 through 18, securing mechanism 260 is seen to include a securing element in the form of an annular recess 262 extending laterally outwardly into the shell member 212 adjacent the lower end 234. a complementary securing element in the form of an annular rib 264 extends laterally outwardly from the bearing member 214, adjacent the base

242 of the bearing member 214. A preferred material for the plastic bearing member 214 is an ultra-high molecular weight polyethylene commonly used in connection with such bearing members, the securing characteristics of which material include a resiliency sufficient to assure that upon inserting the bearing member 214 into the shell member 212, and seating the bearing member 214 in the shell member 212, as seen in FIG. 20, the annular rib 264 is seated within the annular recess 262 to secure the bearing member 214 within the shell member 212.

In order to assure the attainment of the desired orientation of the bearing member 214 within the shell member 212, prior to securement by virtue of the rib 264 entering the annular recess 262, depending fingers 230 will preclude complete insertion of the bearing member 214 into the shell member 212 by abutting the upper lateral surface 254 of flange 246 when the bearing member 214 is in the longitudinal position shown in FIG. 19 and the bearing member 214 is not in the desired orientation. Upon rotation of the bearing member 214 into the desired orientation, notches 266 in the flange 246 are registered with corresponding fingers 230. The notches 266 are configured for allowing the fingers 230 to enter the notches 266, thereby permitting full engagement of the bearing member 214 within the shell member 212 upon proper orientation of the bearing member 214 relative to the shell member 212. Upon such full engagement of the bearing member 214 within the shell member 212, sharp edges 267 on the fingers 230 are embedded within the material of bearing member 214, as shown at 268, for precluding

micromotions between the bearing member 214 and the shell member 212. A small clearance at 269, between portions of the upper lateral surface 254 and corresponding confronting portions of the lower end 224 of the shell member 212, provide purchases for any desired subsequent removal of the bearing member 214 from the shell member 212.

Turning now to FIG. 21, rib 264 is provided with a cross-sectional profile contour configuration 270 for facilitating engagement of the rib 264 within the recess 262, while effecting an enhanced connection between the bearing member 214 and the shell member 212. Profile contour configuration 270 includes an upper section 272 confronting the top 244 at the upper end of the bearing member 214, a lower section 274 confronting the base 242 at the lower end of the bearing member 214, and an intermediate section 276 extending between the upper and lower sections 272 and 274. The upper section 272 makes an acute angle 280 with axial direction 282, and the lower section 274 makes an obtuse angle 284 with the axial direction 282. The intermediate section 276 makes an acute angle 286 with the axial direction 282, the acute angle 286 being smaller than the acute angle 260 so as to establish tapered surfaces 290 and 292 along the upper and intermediate sections 272 and 276, respectively, while the obtuse angle 284 establishes a locking surface 294 along the lower section 274. The tapered surfaces 290 and 292 facilitate the engagement of rib 264 within recess 262 during assembly and the locking surface 294 retains the rib 264 within the recess 262 once assembly is complete. The

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overall profile contour configuration 270 maximizes the area 296 at the root 298 of the rib 264 so that the resistance to shear of the material of the bearing member 214 at the root 298 of the rib 264 is maximized. At the same time, a sharp edge 300 which extends along the recess 262, engages the rib 264 at the locking surface 294, as illustrated at 302, to preclude micromotions between the bearing member 214 and the shell member 212.

Again, should the surgeon determine, either on the basis of a pre-operative assessment of a patient or during the course of the implant procedure, that based upon the needs of a particular patient, as determined by the pre-operative assessment or by an evaluation of conditions encountered at the particular implant site, a bearing material having characteristics other than those of the material of bearing member 214 would be more appropriate, acetabular cup assembly 200 provides the surgeon with the ability to choose, from a kit of component parts providing a plurality of bearing members, a bearing member having a bearing material which exhibits characteristics more appropriate to the needs of that particular patient. Thus, as seen in FIGS. 22 through 25, an alternate bearing member 310 is constructed of a ceramic material and includes a generally domed exterior portion 312 which extends to a top 314. A bearing socket 316 extends upwardly into the bearing member 310 and provides a spherical bearing surface 318 for a complementary femoral head 320 of the proximal end 322 of a femoral component 324.

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As in the embodiment described above in connection with FIGS. 7 through 10, bearing member 310 is provided with an external receptor element in the form of a generally cylindrical securement surface 330 which extends essentially parallel to central axis C of the bearing member 310, between lower end 332 of the bearing member 310 and the domed exterior portion 312. In order to enable simplified interoperative securement of the bearing member 310 within shell member 212, subsequent to locating and seating shell member 212 within the acetabulum, securing mechanism 260 provides appropriate mating tapered surfaces. Thus, securing mechanism 260 includes a metallic securing member shown in the form of a sleeve 340 having an annular ring portion 342 adjacent a lower end 344 and a domed portion 346 extending between the ring portion 342 and an upper end 348. The domed portion 346 is to be received within the counterpart portion of the inner cavity 220 of the shell member 212, and the ring portion 342 is provided with an external securing element in the form of an external seating surface 350 and an internal receptor element in the form of a generally cylindrical internal securement surface 352. The configuration of the internal securement surface 352 and the configuration of the external securement surface 330 are compatible with the particular characteristics of the material of the bearing member 310 so that upon engagement of the external securement surface 330 with the internal securement surface 352, as by an interference fit, the bearing member 310 is secured to the sleeve 340.

Securing mechanism 260 further includes an internal securing element in the form of internal seating surface 354 located on the shell member 212, within the cavity 220 adjacent the lower end 224 of the shell member 212. Internal seating surface 354 is generally complementary to external seating surface 350 for mating engagement of the seating surfaces 350 and 354, as seen in FIG. 24. The seating surfaces 350 and 354 are provided with a tapered configuration, as illustrated by angle 356, the taper of the configuration being compatible with the securing characteristics of the material of the sleeve 340 and the shell member 212 such that the sleeve 340 is secured within the shell member 212 by virtue of the locking of the tapered seating surfaces 350 and 354 in response to engagement of the seating surfaces 350 and 354. In the preferred embodiment, the shell member 212 and the sleeve 340 are constructed of commercially pure titanium and the angle 356 is about 6°. Seating surface 354 includes an upper end 360 and a lower end 362 and is divided by the recess 262 into an upper segment 364 and a lower segment 366. By placing the recess 262 essentially midway between the upper end 360 and the lower end 362, engagement of the seating surfaces 350 and 354, and the locking of the seating surfaces 350 and 354 in response to such engagement is facilitated, by virtue of the locking being accomplished along segments 364 and 366 having generally the same, and therefore maximized, axial length. In this manner, the effectiveness of the seating surface 354 in assuring appropriate alignment between the sleeve 340 and the shell 212 as the sleeve 340 is inserted into the

shell 212 and in subsequently attaining the desired locking engagement with seating surface 350 is not compromised by the presence of the recess 262.

A flange 370 extends laterally outwardly from the lower end 344 of the sleeve 340. In order to assure the attainment of the desired orientation of the sleeve 340, and the bearing member 310, within the shell member 212, prior to securement by virtue of the full seating of the sleeve 340 and bearing member 310, depending fingers 230 will preclude complete insertion of the sleeve 340 into the shell member 212 by abutting upper lateral surface 372 of flange 370 when the sleeve 340 is in the longitudinal position shown in FIG. 23 and the sleeve 340 is not in the desired orientation. Upon rotation of the sleeve 340 into the desired orientation, notches 376 in the flange 370 are registered with corresponding fingers 230. The notches 376 are configured for allowing the fingers 230 to enter the notches 376, thereby permitting full engagement of the sleeve 340, and bearing member 310, within the shell member 212 upon proper orientation and axial alignment of the sleeve 340 relative to the shell member 212. A small clearance at 378, between portions of the upper lateral surface 372 and corresponding confronting portions of the lower end 224 of the shell member 212, provide purchases for any desired subsequent removal of the bearing member 310 from the shell member 212.

As best seen in FIG. 25, as well as in FIGS. 23 and 24, the lower end 332 of the bearing member 310 is spaced upwardly from the

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lower end 344 of the sleeve 340 a prescribed distance 380. With the femoral head 320 of the femoral component 324 engaged in the bearing surface 318 of the bearing member 310, rotational movement of the proximal end 322 of the femoral component 324 is limited by engagement of neck 382 of the femoral component 324 with the lower end 344 of the sleeve 340, as illustrated at 384. In this manner, impingement of the proximal end 322 of the femoral component 324 upon the bearing member 310 is precluded, thus eliminating a potential source of damage to the bearing member 310 when the acetabular cup assembly 200 is in service.

In the modification illustrated in FIG. 26, the lower end of the sleeve 340 is modified, as shown at 390, to receive a ring-like cushion 392 affixed to the lower end 390, the cushion 392 being constructed of a resilient synthetic polymeric material, the cushion 392 thus being interposed between the lower end of the sleeve 340 and the proximal end 322 of the femoral component 324 so as essentially to absorb shock connected with engagement of the proximal end 322 of the femoral component 324 with the sleeve 340.

It will be seen that acetabular cup assemblies 20 and 200 provide a surgeon with a wide range of choices for a pre-operative or an interoperative selection of characteristics of the bearing member of the acetabular cup assembly, with simplicity and lowered cost. Such characteristics include material, size, positioning and orientation. As such, the present invention attains the several objects and advantages summarized above, namely: Accommodates a wide choice of bearing materials in the

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bearing member of an acetabular cup assembly, while utilizing a common acetabular shell; enables the choice of size, position and orientation of the bearing surface of a bearing member selected for assembly with a particular acetabular shell; increases the range of bearing materials, as well as bearing size, positioning and orientation, and renders the choices available in a practical manner for either pre-operative or interoperative selection; allows a surgeon greater latitude in accommodating the needs of different patients while meeting the requirements imposed by various conditions encountered at a particular implant site, and enables appropriate choices to be made interoperatively, as well as pre-operatively; promotes greater accuracy in the replacement of a natural hip joint, with increased economy; provides a surgeon with the ability to make both pre-operative choices and interoperative choices from a wider range of options; enables the securement of a bearing member of selected material within a common acetabular shell, with increased ease and economy, and without complex, specialized instruments; provides an acetabular cup assembly having a bearing member of appropriate bearing material and accurate sizing, positioning and orientation, with economy of manufacture and use, and long-term reliability.

It is to be understood that the above detailed description of preferred embodiments of the invention is provided by way of example only. Various details of design, construction and procedure may be modified without departing from the true spirit and scope of the invention, as set forth in the appended claims.